Project FY22-DU-011: Integration of Major FHB-resistant QTL into Modern Durum Wheat Varieties

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1. What are the major goals and objectives of the research project?

The objective of this project is to continue developing elite durum germplasm with improved FHB resistance derived from diploid, tetraploid and hexaploid wheat accessions.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

What were the major activities?

- Conducted yield trials for 37 breeding lines with *Fhb1* and low cadmium gene at two locations (Prosper and Langdon, ND) for the 3rd year from May to September 2024. The seed samples are currently being processed for yield data and test for end-use quality and DON. These lines were also evaluated in the FHB nursery at two locations in Prosper and Fargo, ND. These lines were selected from the 212 lines derived from backcrossing durum line D151343 (15Entry 255) to ND Riveland and breeding lines Carpio_Cdu1 and Joppa_Cdu1 and three varieties (Carpio, Joppa, and ND Riveland). The data from the yield trail in Prosper in 2022 showed that 10 elite durum lines had higher grain yields than check varieties Carpio and Joppa and four lines also had similar yields compared to ND Riveland. The data from the Langdon 2023 trial showed that 12 had higher grain yields than Carpio. The data from the yield trail in Prosper in 2024 showed that 18 elite durum lines had higher grain yields than check varieties Carpio, Joppa, and Riveland. The data from the yield trail in Langdon in 2024 showed that 15 elite durum lines had higher grain yields than check varieties Carpio, Joppa, and Riveland. The seed samples from these trials are being tested for DON contents and end-use quality.

- Five of the 37 breeding lines (above) with higher grain yields than check varieties (Carpio and Joppa) were tested in the elite yield trials in multiple locations in the NDSU durum wheat breeding programs in the summer of 2023. Based on the yield and quality data from 2023 trials, two breeding lines were selected and included in the elite yield trials for the 2nd year in the summer of 2024.

- Planted and evaluated 167 new durum lines (BC_1F_5) carrying *Fhb1*, PI277012-derived 5A QTL, and *Cdu1* and 23 lines without *Fhb1* and 5A QTL as checks in FHB nurseries at Fargo and Prosper, ND during the summer season of 2024. These lines were previously selected by genotyping over 2,500 BC_2F_2 plants derived from backcrossing durum lines 15Entry 104, 15Entry 111, 15Entry 129, 15Entry 269, 15Entry 271, and 15Entry 295 with durum variety 'ND Riveland'. Forty-nine lines showed resistance in at least two replications in Prosper location, but all the lines in Fargo FHB nursery were highly susceptible due to high disease pressure. A set of 36 elite lines carrying low cadmium gene, *Fhb1*, and 5AL-QTL were selected and were planted at Fargo FHB nursery for further evaluation for the first year in 2025. These lines were also included in the yield trial at Prosper and Langdon for the first year in 2025.

- Produced BC_1F_1 hybrids between ND Riverland and a wheat-*Th. ponticum* 7B/7el2 introgression line SN-26 carrying *Fhb7*.

- Produced BC_5F_1 hybrids between ND Riverland and a wheat-*Th. elongatum* 7B/7E introgression line XWC14-255-13-1 (WGC002) carrying new *Fhb7* allele $Fhb7^{Th2}$.

- Developed BC_5F_1 population by backcrossing Chinese wheat landrace 'Wangshuibai' with ND Riverland to simultaneously transfer major FHB resistance QTL *Fhb1*, *Fhb2*, *Fhb4*, and *Fhb5*.

What were the significant results?

- A set of 36 new durum breeding lines carrying low cadmium gene, Fhb1, and 5AL-QTL were selected and were planted at Fargo FHB nursery for further evaluation for the first year in 2025. These lines were also included in the yield trial at Prosper and Langdon for the first year in 2025.

- The BC_5F_1 populations from backcrossing Chinese wheat landrace 'Wangshuibai' and a wheat-*Th. elongatum* 7B/7E introgression line XWC14-255-13-1 (WGC002) with ND Riverland have been developed to transfer major FHB resistance QTL *Fhb1*, *Fhb2*, *Fhb4*, *Fhb5,* and *Fhb7*. These populations are being used for selecting elite durum lines with stacked multiple FHB resistance QTL.

List key outcomes or other achievements.

A large number of elite durum breeding lines carrying *Cdu1*, *Fhb1*, and/or two PI277012-derived 5AS/5AL QTL have been developed and provided to the NDSU durum wheat breeding programs and they are evaluated in various breeding trials.

3. What opportunities for training and professional development has the project provided?

This project provides training and professional development for a postdoctoral research associate.

4. How have the results been disseminated to communities of interest?

The results have been disseminated through publications and presentations at various workshops and seminars and communications with breeders and collaborators.

5. What do you plan to do during the next reporting period to accomplish the goals and objectives?

- Complete final-year (2025) yield trial and FHB evaluation for 37 new durum lines carrying *Fhb1*, PI277012-derived 5A QTL, and *Cdu1*, summarize and analyze the data (FHB severities, DON contents, yield, end-use quality, and agronomic characteristics) from the experiments at multiple locations in the past three years, share the results with NDSU durum breeder to select 5 -10 top lines to be used in the durum breeding programs, and prepare manuscript for publication in peer-reviewed journal .
- Complete the introgressions of multiple FHB resistance QTL (*Fhb1, Fhb2*, *Fhb4*, *Fhb5*, *Fhb7*, and 5A QTL from PI 277012) into durum wheat varieties, and initiate FHB evaluation and yield trial for newly developed durum lines carrying multiple resistance QTL.